CHAPTER VII

ECONOMIC ANALYSIS

7.1 THE PROBLEM

The objective of an economic analysis is to determine the most cost effective configuration from among the set of workable design alternatives considered to be technically feasible. Selection of the most economical solution requires a detailed investigation of these feasible alternative system configurations.

The complete series of events involved in a munitions operation must be studied in a stepwise sequence to determine where the greatest hazards exist. Each identified hazard is then isolated for determination of methods of reducing the hazard. In some cases, proven protective systems capable of reducing the hazard may be applied without modification. In other cases, alternate systems must be designed to fit the particular requirements of interest.

The final selection of a protective, or hazard reduction, system may be based partially on considerations which do not have a definable dollar value. For example, items such as time lost in repair of munition lines damaged by an accidental detonation may enter into the final choice. Generally, however, the alternatives will all be designed to provide the desired level of reliability and safety, and dollar costs will be the determining factor in selecting one system or another.

7.2 CONSIDERATIONS

The number of factors entering into the process for evaluating the merits of different methods of providing adequate protection to a hazardous operation can be quite extensive. Although each installation may be unique in its requirements, there are certain considerations which are common to all applications. For example, the general methods of providing protection require consideration in every application. These are

- Dispersal based on unbarricaded quantity-distance requirements.
- Dispersal based on barricaded quantity-distance requirements using reinforced concrete blast walls.
- Using suppressive shields to reduce quantity-distance requirements.

The first two methods listed above have been in existence for some time and have been successfully utilized many times in the past. Reference 7-1 provides guidance on quantity-distance requirements; design of reinforced concrete blast walls is covered in Ref. 7-2. Suppressive shields, the subject of this handbook, have also been proven successful in safely reducing separation requirements between hazardous operations and providing the required safety in the operating plant environment.

In the most general of terms, it may be found that a plant designed on the basis of unbarricaded quantity-distance requirements is most economical in areas where real estate, utilities, and labor are abundant at low cost. Suppressive shields may be found to be the most economical approach where the inverse is true and the hazardous operations must be kept as near each other as possible. The use of reinforced concrete barricades may be the most economical solution in areas of intermediate real estate, utilities and labor cost. One must also remain alert to the possible advantages of combining two or all three of the methods in particular situations.

Representative items which can be expected to require consideration in any economic analysis of munitions plant alternative designs are listed in Table 7-1. Although by no means all-inclusive, the list in Table 7-1 is furnished as a starting point for items to be considered in the preparation of an economic analysis.

Table 7-1

REPRESENTATIVE ITEMS TO CONSIDER
IN AN ECONOMIC ANALYSIS

- ACCESS ROADS
- BUILDINGS
  - Production
  - Igloos
  - Office
  - Change Rooms
  - Cafeteria
  - Laundry
- COVERED RAMPS
- PAVING
  - Concrete
  - Asphalt
  - Improved
- STORM DRAINS
- LIGHTING
  - Street
  - Parking
- FIRE PROTECTION
- RAILROAD
- SITE ROADS
- FENCE
- GUARD HOUSE
- PARKING
- LANDSCAPING
- BARRICADES
- SUPPRESSIVE SHIELDS
- CONVEYORS
- UTILITIES
  - Electrical
  - Communications
  - Water
  - Steam and Condensate
  - Compressed Air
  - Sanitary Sewage
  - Heating, Ventilating and Air Conditioning
- LAND

7.3 METHOD

It has probably become apparent at this point that the only realistic basis upon which to base an economic analysis is investigation of the available alternative systems in the criteria development stage. To begin the process, the entire sequence of operations that must be performed is separated into discrete steps. The operations are then combined into compatible groups which can be safely consolidated into separate buildings or areas of the same building. The number of operations and the desired production capacity will determine the area and the size of the building, or buildings, required.

One or more layouts to accomplish the required functions are then developed based on the protective method, or combination of methods, being utilized. The compatible hazardous operations are located by unbarricaded quantity-distance requirements, barricaded quantity-distance requirements, and/or suppressive shield separation distances. The investigation is now at the point where criteria will be required. Reinforced concrete barricades should be designed. Suppressive shields should be selected or designed by the procedures described in preceding chapters. Reference 7-3 can be very helpful in estimating reinforced concrete barricade costs. Reference 7-4 is suggested for estimating all other construction costs.

With the various alternative layouts and preliminary facility designs established as outlined above, it will be possible to estimate initial real estate and facilities costs. Subsequently, estimates of the recurring costs for the candidate designs can be made.

Recurring costs include operating and maintenance costs which continue throughout the life of the facility, as opposed to the one-time nonrecurring costs which include all labor, material, plant and equipment costs required to initiate production. It may be found in some cases that the recurring costs

are insignificant with respect to the nonrecurring costs. This will not necessarily always be the case, however, and recurring costs should be considered until analysis shows that they can be safely neglected.

There will be overriding factors in some cases that will rule out possible alternative layouts and designs. The most common of such factors are limited real estate availability and the requirement to utilize existing facilities. These factors may make the economic analyses simpler or more complex, depending upon the particular circumstances.

7.4 EXAMPLE ECONOMIC ANALYSES

An economic analysis of hazardous operation facilities is not notably different from economic analysis of more conventional plant facilities. Alternative acceptable configurations must be conceived; the usual as well as the unusual items must be designed; and the various alternative designs must be developed to the extent that valid economic comparisons can be made between the candidate configurations.

Since there are a number of possibilities and considerations that will arise in economic analyses of munitions plant facilities, it is believed that the best way to illustrate the methods and procedures involved is by specific examples. These examples are presented in Refs. 7-5 and 7-6. The first example is an analysis of an improved conventional munition LAP facility (Ref. 7-5). The second example is an analysis of a 105-mm high explosive melt-pour facility (Ref. 7-6).

The first example analysis evaluates layouts and develops alternative layouts using suppressive shields around hazardous explosive operations with the objective of determining the most economical facility that will meet production requirements for both peak production and for guaranteed production in case of

an accidental detonation. The second example analysis develops five alternative layouts which employ suppressive shielding and compares these five designs with a proposed design concept which did not utilize suppressive shields. Recurring operating, maintenance and energy use costs are included in the second example analysis.

Both example analyses find that the use of suppressive shielding technology can result in meaningful savings in the cost of munitions plant construction.

7.5 REFERENCES

7-1 Safety Manual, AMCR 385-100, U.S. Army Material Command, Alexandria, Va., Latest Edition. (U)

7-2 Structures to Resist the Effects of Accidental Explosions, TM5-1300, Department of the Army, Washington, D.C., June 1969. (U)

7-3 Dede, M., et al, Preliminary Estimate of Concrete Thicknesses and Construction Costs of Laced Reinforced Concrete Structures, Technical Report No. 4441, Picatinny Arsenal, Dover, N.J., October 1972. (U)

7-4 Building Construction Cost Data, Robert Snow Means Co., Inc., 100 Construction Plaza, Duxbury, Mass., Latest Edition. (U)

7-5 Nelson, K.P., The Economics of Applying Suppressive Shielding to the M483A1 Improved Conventional Munition LAP Facility, EM-TR-76087, Edgewood Arsenal, Aberdeen Proving Ground, Md., January 1977. (U)

7-6 Wenzel, A.B., et al, An Economic Analysis of the Use of Suppressive Structures in the Lone Star Army Ammunition Plant 105-mm High Explosive Melt-Pour Facility, EM-CR-76032, Edgewood Arsenal, Aberdeen Proving Ground, Md., November 1975. (U)